Monthly Labor Review

BLS

February 2022

Challenges in calculating occupational fatality rates

The U.S. Bureau of Labor Statistics produces data on occupational injuries and fatalities. Calculating these data is generally straightforward. However, some occupations, like firefighters, young farm workers, and police officers, pose more of a challenge because of complications with available data. This article explores the data available for calculating fatality rates in these occupations and the challenges associated with producing accurate calculations.

In this article, we explore the data available on occupational fatalities among those working as firefighters, farmers, and police officers. In all three cases, the nature of work schedules and employment relationships makes it challenging to calculate fatal injury rates that completely align with the risk associated with working in these occupations. This information can help data users to better understand how to interpret the risk associated with these occupations and the challenges with producing fatality rates.

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Census of Fatal Occupational Injuries

The Census of Fatal Occupational Injuries (CFOI) seeks to produce a complete count of all fatalities that occur during the calendar year that are the result of workplace injuries. The data are compiled from a variety of sources, including death certificates, coroners' reports, and news articles. The CFOI program uses diverse state, federal, and independent data sources to identify, verify, and describe fatal work injuries. Using a wide range of data sources ensures that fatality counts are as complete and accurate as possible.

CFOI data help safety and health experts and policymakers monitor the number and types of deadly work injuries over time. The data are also used to identify factors associated with particularly high risks, such as driving a tractor-trailer truck or working in the commercial fishing industry. Fatal injury profiles can be generated from the CFOI database for specific worker populations (such as the self-employed or female workers), for certain types of machinery (such as farm equipment), and for specific fatal circumstances (such as pedestrian fatalities in a work

zone).[1] Such profiles help identify existing work standards that may require revision and help highlight safety hazards where intervention strategies may need to be developed.

Calculating rates

Fatality rates help data users to understand the relative risk of industries and occupations, as well as the demographic characteristics of those taking on the risks. For example, although there were more total fatalities among cashiers than logging workers in 2019 (51 versus 46), the risk is about 30 times higher for logging workers because of the differences in employment between logging workers and cashiers. Calculating the fatality rate of each occupation results in a common scale of risk, which allows comparisons across different groups of workers and across time.

The CFOI uses an hours-based method for calculating rates, measuring the number of fatalities among 100,000 full-time workers. In this calculation, we assume a full-time worker averages 40 hours per week, 50 weeks per year. Rates are calculated using the following formula:

$$R = \left(\frac{N}{EH}\right) * 200{,}000{,}000,$$

where R is the hours-based rate of fatal injuries for a group, N is the number of fatal injuries in a group, EH is the total hours worked by all employees in a group during the calendar year, and 200,000,000 is the base number of hours for 100,000 full-time equivalent workers (working 40 hours per week, 50 weeks per year).

The total hours worked by all employees in a group during the calendar year is calculated with data from the Current Population Survey (CPS). This household survey is conducted monthly by the U.S. Census Bureau on behalf of BLS and gathers information about employment from any person 16 years or older within a sampled household. People are considered employed if, during the reference week, they did any work at all as paid employees; worked in their own business, profession, or on their own farm; or worked without pay at least 15 hours in a family business or farm.

The scope of the CFOI is far broader. Data are collected for workers of any age, any worker status (including volunteers), and, in some cases, when the injury occurs to an off-duty worker. Because the scopes of the CFOI and the CPS differ, when calculating the rates the CFOI removes most fatalities that do not have a matching CPS hours measure. Although this allows BLS to compute rates with the same pool of workers in the numerator and denominator, it also means that certain rates may be misinterpreted by users who assume these rates account for all workers in a group.

As an example, in 2018 there were 5,250 fatalities resulting from occupational injuries. Using a CPS estimate of 292,528 million hours worked, BLS reported a fatality rate of 3.5 cases per 100,000 full-time equivalent workers.[2] What is not clear from the reported table is that the actual numerator used to calculate the rate is 5,091 fatalities, which excludes volunteers, active-duty resident military personnel, and those under age 16. The CFOI removes these cases because workers in these occupations are not in scope for the CPS hours measures, and so they are excluded from both the numerator and denominator for consistency.

The CFOI bases the calculation on a full-time equivalent worker measure, effectively calibrating the hours by assuming a 2,000-hour work year, rather than simply dividing cases by the number of workers. This method makes it easier to compare industries and occupations characterized by many part-time workers with those that are mainly composed of full-time workers.[3] However, although using an hours-based rate does allow a more straightforward comparison of risk per hour worked, it creates problems when considering the risks of jobs that are not characterized by a traditional 40-hour-per-week schedule, as well as jobs whose hours in the CPS may not include a complete measure of time exposed to work-related hazards.

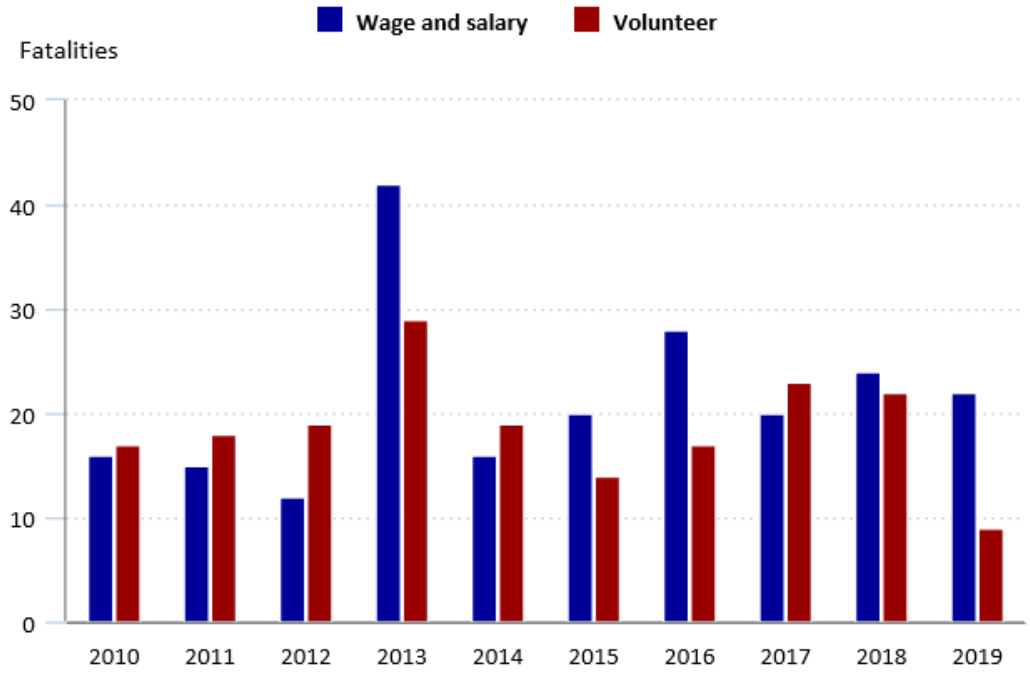
To illustrate this concept, we explore the fatality rate calculations for firefighters, young farm workers, and police officers to demonstrate the challenges with calculating rates for populations that pose measurement challenges due to CFOI classifications, CPS hours measurement, or both.

Firefighters

One of the most challenging occupations for calculating risk in the CFOI is firefighters because a large portion of firefighters work as volunteers rather than as paid workers. The National Fire Protection Association estimates that out of approximately 1.1 million firefighters in the United States in 2018, only 370,000 of them worked as career firefighters (roughly 34 percent) and the rest were volunteers. Volunteers are much more common in rural areas while career firefighters are more common in urban areas. Although the number of career firefighters has been increasing steadily over the last several decades, volunteers still account for approximately two-thirds of firefighters in the United States.[4]

The CFOI program aims to capture information about fatalities for any worker status, which includes both paid workers and volunteers. For most occupations, there are very few volunteer fatalities, which means rates are straightforward to calculate. However, approximately half of all firefighter fatalities are among volunteers. (See chart 1.) Because volunteers are not included in the total hours worked used in our rate calculation, we also remove fatalities of volunteers from the numerator. That means our rate calculation can only be considered to show the risk for one-third of firefighters: those that are paid to work, and not the volunteers.

Chart 1. Total fatalities among firefighters and supervisors of firefighters, wage and salary or volunteer, 2010–19



Click legend items to change data display. Hover over chart to view data.
Source: U.S. Bureau of Labor Statistics, Census of Fatal Occupational Injuries.

In 2018, there were 66 fatalities among workers classified as volunteers; 18 of these were firefighters and 4 more were first-line supervisors of firefighters. There were 46 total fatalities among firefighters and their first-line supervisors, but only the 14 that were paid, nonsupervisory employees were used to calculate the published fatality rate of 3.4 cases per 100,000 full-time equivalent workers. The other cases involved volunteers and other categories that are outside the scope of the CPS hours calculations, or first-line supervisors of firefighters who are included in a different occupational code. The fact that paid firefighters are 34 percent of the workforce and 44 percent of cases suggests a higher risk profile. However, since we cannot compare using hours worked as a basis, we cannot determine an overall rate for this occupation.

A second issue is that firefighters often work more than a 40-hour workweek. It is common for firefighters to work 24-hour shifts followed by 48 or 72 hours off.[5] Firefighters are even treated differently under the Fair Labor Standards Act, which states they can work up to 53 hours per week before it is required for employers to pay overtime; for most jobs, this is 40 hours per week.[6]

If the goal of CFOI rates is to show the risk that 100,000 full-time equivalent workers face, the previously mentioned formula would not properly capture that information. Because paid full-time firefighters, on average, work more hours per week than do full-time workers in most occupations, the hours-based method underestimates the risk per worker. For example, if we assume that a full-time paid firefighter worked on average 50 hours per week in 2018, the fatality rate would be equivalent to 4.2 per 100,000 full-time equivalent workers, as opposed to the published rate of 3.4.[7]

Young farm workers

Farming also poses some challenges when calculating rates. Since 2011, there have been around 400 fatalities each year in farming occupations. (See table 1.) Given the number of fatalities in farm occupations each year, the CFOI would like to produce rates that accurately reflect the risk to these workers.

Table 1. Total fatalities among farm workers, for select occupations, 2011–19

Year	Farmers, ranchers, and other agricultural managers	Agricultural equipment operators	Farmworkers and laborers, crop, nursery, and greenhouse	Farmworkers, farm, ranch, and aquacultural animals	Total
2011	268	11	78	42	399
2012	232	10	80	54	376
2013	231	5	72	47	355
2014	270	9	80	57	416
2015	252	11	106	55	424
2016	260	14	78	61	413
2017	258	17	85	52	412
2018	257	8	78	60	403
2019	238	17	87	73	415

Note: The Census of Fatal Occupational Injuries uses the Standard Occupation Classification to define occupations.

Source: U.S. Bureau of Labor Statistics, Census of Fatal Occupational Injuries.

Although some of these fatalities occur on large farms with large staffs, many farms are family-operated affairs with little or no staff from outside the family. The U.S. Department of Agriculture designates a family farm as “any farm organized as a sole proprietorship, partnership, or family corporation. Family farms exclude farms organized as nonfamily corporations or cooperatives, as well as farms with hired managers.” Under that definition, 96 percent of the approximately 2.2 million farms in the United States are considered family farms, and more than 1.9 million of those family farms gross less than $250,000 per year.[8]

It is common for family members, even children who would normally be prohibited from working, to work on family farms. Federal law says that “[a] child of any age may be employed by his or her parent or person standing in place of the parent at any time in any occupation on a farm owned or operated by that parent or person standing in place of that parent.”[9] Besides allowing children to work on farms owned by their parents or in instances in which parental consent is provided, federal law allows minors age 14 and over to do certain jobs on farms. While some state laws are stricter than these federal guidelines, there are many young farmworkers throughout the country. In 2014, the Centers for Disease Control estimated that more than 600,000 children under the age of 16 worked on farms in the United States.[10]

Table 2 shows the number of fatalities each year among farmworkers under the age of 16. However, the challenge for calculating the risk to these workers is that the CPS program does not collect information regarding hours worked for those under the age of 16. Therefore, the CFOI program chooses to remove these workers from its calculations and only produces a rate for workers age 16 and older. This means we are not fully capturing the risk that exists to these workers and are specifically missing a vulnerable population.

Table 2. Fatalities among farm workers under age 16, by year, 2011–19

Year	Fatalities
2011	8
2012	14
2013	4
2014	3
2015	11
2016	9
2017	7
2018	9
2019	12

Source: U.S. Bureau of Labor Statistics, Census of Fatal Occupational Injuries.

Besides excluding workers under the age of 16, the way in which we estimate fatality rates for workers 16 and older who work on farms owned by their families may lead to inaccuracies. Between 2011 and 2019, there were 36 fatalities among farm workers ages 16 to 18 who worked for their family business. Because of the nature of CFOI data collection, it is hard to know whether these workers would have been counted in the CPS hours estimates. In order to be counted as employed by CPS, the workers would either need to be paid workers or work in the family business without pay for at least 15 hours during the reference week. In 2018, the published fatality rate for farm workers was 18.0 per 100,000 full-time equivalent workers. If we remove all farm workers 18 and younger from the numerator because we cannot be sure they would be counted in the CPS numbers, the rate drops to 17.4 fatalities per 100,000 full-time equivalent workers. Because we do not know whether these workers would be counted in the CPS numbers, we cannot affirmatively say which of these figures best represents the fatality rate among farm workers, but we are confident that the true rate is in the range of these two figures. This challenge of aligning the numerator of fatalities with the CPS hours estimate in the denominator means that the published rate estimate may not fully capture the risk in this occupation.

Police officers

Since 1996, the CFOI has collected data on fatalities to police officers resulting from certain injuries that occur while the officer is off duty. The CFOI generally considers homicides occurring to off-duty police officers to be in scope. Additionally, other fatalities to off-duty police are in scope if the officers are performing a police-related function, such as directing traffic at the scene of an accident or rescuing someone from a fire. The decision to collect these data is with the recognition that it is not uncommon for off-duty police to be at risk even outside official work hours because of the nature of their occupation. Between 2010 and 2019, there were 37 fatalities among police officers who were off duty at the time of their injury.

In calculating the fatality rate for police, BLS includes the fatalities to off-duty police in the numerator. This addition is despite our inability to accurately account for the fatalities in the denominator, because the number of hours only captures on-duty time. The general goal of producing the hours-based rates is that they estimate the risk of fatality a worker faces during the year while working a typical 40-hour workweek. However, because the risk can exist outside of on-duty hours, and we want to capture that information along with the risk faced while in work status, we include both values in the numerator. That means the rate of fatalities for police officers does not represent the on-duty risk in the same fashion as the rate does for other occupations. In 2017, the published fatality rate for police officers was 12.9 per 100,000 full-time equivalent workers. Removing the off-duty police from this number, the fatality rate drops to 12.5 per 100,000 full-time equivalent workers, which better represents the on-duty risk.

However, while eliminating off-duty fatalities from the count of fatalities would result in a fatal rate measurement comparable to other occupations, it would also fail to account for the risks that police face while off duty.

Summary

Our goal in the CFOI program is to accurately represent the risk faced by employees in various occupations and industries. These risks are expressed as rates that are an estimate of the number of fatalities among 100,000 full-time equivalent workers. Although calculating these rates is straightforward for most occupations, it poses unique challenges in the case of firefighters, young farm workers, and police officers. The special circumstances of these occupations make it difficult for the CFOI program to accurately estimate and convey their risk levels.

The CFOI program strives for accuracy and transparency. Although the published fatality rates for firefighters, young farm workers, and police officers may not change drastically when we recalculate them with different assumptions, the goal of this article is to demonstrate the challenges we face in providing this crucial information and our attempts to reflect the data as accurately as possible while also acknowledging our shortcomings. In the short term, we will strive to improve our labeling to ensure that users understand exactly what is represented by our published statistics. In the long term, we will review our methods and make sure that our published rates represent the risk of workers as best as possible.

SUGGESTED CITATION

Ellen Galantucci and Kristen Monaco, "Challenges in calculating occupational fatality rates," *Monthly Labor Review,* U.S. Bureau of Labor Statistics, February 2022, https://doi.org/10.21916/mlr.2022.7.

NOTES

1 For fatal injury profiles, see “Occupational injuries and illnesses and fatal injuries profiles,” *Injuries, illnesses, and fatalities* (U.S. Bureau of Labor Statistics), https://www.bls.gov/iif/data.htm.

2 For the data used in this example, see “Fatal occupational injuries, total hours worked, and rates of fatal occupational injuries by selected worker characteristics, occupations, and industries, civilian workers, 2018” (U.S. Bureau of Labor Statistics, 2019), https://www.bls.gov/iif/oshwc/cfoi/cfoi_rates_2018hb.xlsx.

3 For more information on the differences between hours-based rates and employment-based rates of fatalities, see “Census of Fatal Occupational Injuries — hours-based rates,” *Injuries, illnesses, and fatalities* (U.S. Bureau of Labor Statistics), https://www.bls.gov/iif/oshnotice10.htm, and see John W. Ruser, “Denominator choice in the calculation of workplace fatality rates,” *American Journal of Industrial Medicine,* vol. 33, no. 2, February 1998, pp. 151–56, https://doi.org/10.1002/(SICI)1097-0274(199802)33:2%3C151::AID-AJIM6%3E3.0.CO;2-0.

4 See Ben Evarts and Gary P. Stein, “[U.S.] fire department profile 2018” (National Fire Protection Association, 2020), https://www.nfpa.org/-/media/Files/News-and-Research/Fire-statistics-and-reports/Emergency-responders/osfdprofile.pdf.

5 For more information, see “Firefighters,” in *Occupational Outlook Handbook* (U.S. Bureau of Labor Statistics, 2021), https://www.bls.gov/ooh/protective-service/firefighters.htm

6 See "[Fair Labor Standards Act] and firefighters" (Albany, NY: Chamberlain, Kaufman, and Jones, Attorneys at Law), http://flsa.com/fire.html.

7 Calculated using the formula

$$R = \left(\frac{N}{EH}\right) * 250{,}000{,}000,$$

where R is the hours-based rate of fatal injuries for a group, N is the number of fatal injuries in a group, EH is the total hours worked by all employees in a group during the calendar year, and 250,000,000 is the equivalent of 100,000 workers working 50 hours per week, 50 weeks per year.

8 “Family farms” (U.S. Department of Agriculture, National Institute of Food and Agriculture, no date), https://nifa.usda.gov/family-farms.

9 “Child labor requirements in agricultural operations under the Fair Labor Standards Act," Child Labor Bulletin 102 (U.S. Department of Labor, revised November 2016), https://www.dol.gov/sites/dolgov/files/WHD/legacy/files/childlabor102.pdf.

10 "Table D-5. National estimates of household youth (<20 years) on US farms by type of farm and age group“ (National Institute for Occupational Safety and Health, Centers for Disease Control and Prevention, April 10, 2018), https://www.cdc.gov/niosh/topics/childag/cais/pdfs/d-5-508.pdf.

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